

## PATENT COOPERATION TREATY

## PCT

REC'D 15 MAR 2005


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## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 49709-1	<b>FOR FURTHER ACTION</b>		See Form PCT/PEA/416
International application No. PCT/CA 03/01278	International filing date (day/month/year) 21.08.2003	Priority date (day/month/year) 29.08.2002	
International Patent Classification (IPC) or national classification and IPC H01L31/0224			
Applicant DAY4 ENERGY INC. et al.			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 3 sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand  15.03.2004		Date of completion of this report  14.03.2005	
Name and mailing address of the International preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer  Werner, A  Telephone No. +49 89 2399-2272	



**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/CA 03/01278

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

**Description, Pages**

3-14	as originally filed
1, 2, 2a	received on 12.03.2004 with letter of 12.03.2004

**Claims, Numbers**

1-19	as originally filed
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**Drawings, Sheets**

1/19-19/19	as originally filed
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- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/CA 03/01278

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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**1. Statement**

Novelty (N)	Yes: Claims	1-19
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-19
Industrial applicability (IA)	Yes: Claims	1-19
	No: Claims	

**2. Citations and explanations (Rule 70.7):**

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

PCT/CA 03/01278

**Re Item V**

**Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:

D1: US-A-4 380 112 (LITTLE ROGER G) 19 April 1983 (1983-04-19)

D2: EP-A-0 807 980 (CANON KK) 19 November 1997 (1997-11-19)

2. The subject matter of claims 1-19 does not involve an inventive step (Art. 33(3) PCT).

2.1 D1 (cf. col. 6, lines 62- col. 8, l. 25, Figs. 9,10) all the features of claims 1,2,6, cf. wire (24), terminal bar (28), insulating optically transparent film (34), adhesive layer (34) (it is evident that the "transparent cover plate (34)", made of e.g. transparent plastic (cf. col. 7, lines 1-5) has also to some extent adhesive properties (cf. col. 7, lines 14- 17), i.e. the "transparent cover plate" can be considered as a first film optical transparent film (e.g. 34') and an adhesive layer (34'')) -except the coating consisting of an allow with low melting point.

It is well known (cf. e.g. D2, page 2, lines 28-33) that solder (i.e. a alloy with a low melting point) facilitates the connection of a wire with a terminal bar.

Therefore, the subject matter of claims 1,2,6 does not involve an inventive step over D1 and D2.

2.2 The additional features of claims 3-5,7-19 are obvious.

## Electrode for photovoltaic cells, photovoltaic cell and photovoltaic module

The invention relates to an electrode for contacting electrically conductive surfaces, in particular for contacting one or a plurality of photovoltaic (PV) elements being part of a photovoltaic cell or solar cell. The invention further relates to photovoltaic cells produced with this electrode.

The generation of electrical energy using photovoltaic technology has reached a high standard. However, the production of PV cells and PV modules is still rather complicated and expensive. Also the efficiency of energy generation using PV modules with a maximum efficiency of about 17 % is rather low. From an economic point of view the generation of electric power using photovoltaic technology is only acceptable under current conditions if it is supported and/or subsidized by some means, e.g. by the so called 100 000-roofs program in Germany or similar programs in California, USA. Thus, in the field of photovoltaic technology there still remains a critical requirement to lower the production costs and to enhance the efficiency of the energy generation using PV elements and PV modules.

Commonly used PV cells comprise a semiconductor element with a junction of the type ( $n^+n$ (or  $p$ ) $p^+$ ) on the basis of mono- or multicrystalline silicon, amorphous silicon and other thin-film semiconductors with an embedded p-n junction. One surface of the element is usually covered with a metal layer, such as aluminum or stainless steel, while the other surface is provided with an anti-reflective coating. Both surfaces are in contact with electrodes, which collect and carry off the generated electrical energy. This structure is embedded between transparent protective layers, such as glass.

The electrodes are all produced using screen-printing technology. However, electrodes produced this way have a high series resistance. Apart from this, expensive devices and equipment are required for the production and cost reduction is limited when this technology is employed.

US 4 380 112 A (Little) discloses a photovoltaic element comprising an electrode for contacting a surface of said PV element, said electrode comprising an electrically insulating optically transparent carrier. The wires of the electrode are embedded in the electrically insulating optically transparent carrier so that the electrode wires are exposed at one, the "inner" side thereof. Completion of the PV element is effected by electrostatically bonding the inner surface of the transparent film, together with the mesh components, to the exposed face of the front semiconductor element.

The electrically insulating, optically transparent film is made from glass so that embedding the wire mesh into the film involves pressing and heating the structure to a temperature of about 700 °C (glass melting point). A permanent contact between the metallic wires and the semiconductor surface is formed by an electrostatically bonding step, i. e. a strong voltage is applied across the glass + metallic wire + semiconductor sandwich that is again heated up to 700 °C.

The heating of the structures during the manufacture of the electrode and of the PV element is complicated and cumbersome so that the production cost is relatively high. Moreover the repeated heating steps bear the risk of faults and generation of trash.

EP 0 807 980 A (Canon KK) and US 5 759 291 A (Ichinose et al.) disclose a semiconductor element (wafer) with parallel metallic contact or current collecting wires (electrodes) which are fixed to the surface of the element by means of a conductive adhesive in which conductive particles are dispersed. The electrode wires are arranged in parallel between connecting conductors which are running along the edges of the element. For this type of electrode the ohmic contact between the semiconductor surface and the wires is relatively high, which results in a high energy loss and a low efficiency, especially under concentrated solar radiation. Also, the production of such PV cell is rather complicated.

From US 5 084 107 A (Deguchi et. al.) a similar solar cell and array of solar cells are known, wherein metallic electrode wires are adhered to the surface of the photovoltaic element by means of an adhesive material. In the adhesive, conductive particles are dispersed. Also with this electrode structure, the production costs and the contact resistance between the wires and the surface of the element are fairly high.

From US 5 158 618 A (Rubin et al.) an electrode structure is known, wherein the contact wires are embedded in a transparent polymer block in such a way, that they partly protrude from the polymer block. Said electrodes contact the element from one or from two sides and are sandwiched between transparent protective layers, such as glass. As the wires of the electrode are, for example, configured as coils, there are only point contacts between the wires and the surface of the PV element. Thus, also in this case the series resistance of a PV cell is relatively high. Also the production costs are relatively high, since the automated production of such types of solar cells and PV modules is not possible.

US 5 457 057 A describes a current collecting electrode comprising metal wires, at least a part of said metal wires being coated by conductive paste.

In view of the prior art discussed above it is an object of the present invention to provide for an electrode, in particular for PV elements, which can be produced effectively as a separate product and attached to the surface to be contacted in an effective and gentle manner.

It is also an objective of the invention is therefore to provide for an electrode which at low production costs achieves a lower contact resistance between the electrodes and a conductive surface, in particular the surface or surfaces of a photovoltaic element.

A further objective of the invention is to provide for a PV cell which allows, by using such an electrode, lowering the combined series resistance and the production costs of PV cells and PV modules and enhancement of their efficiency.

According to the invention these object are solved in that an adhesive layer is provided on one surface of the electrically insulating, optically transparent film, the electrically conductive wires being embedded into said adhesive layer, a part of the surfaces of said wires protruding from the adhesive layer, wherein and at least on the surface protruding from the adhesive layer said wires are covered by a coating consisting of an alloy with a low melting point.

During manufacture of the electrode of the invention the adhesive layer must be heated only to a very low temperature (melting point of the adhesive layer of about 100 °C): A permanent contact between the metallic wire and the semiconductor surface is formed after pressure is applied on the polymeric film with the preliminarily embedded metallic wire that is pressed and heated only up to 130 °C. Thereby an intimate mechanical and electrical contact is obtained between the surface to be contacted and the wire.

Preferably, a second plurality of wires substantially running parallel to each other is disposed between the transparent film and the wires of said first plurality, the wires of the first and second pluralities forming together a mesh, and the wires of the second plurality being electrically connected to a second terminal bar.

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## Fiche d'accompagnement - Routing slip

A To ISA/EP		
Pour suite à donner		For action
Pour approbation		For approval
Pour signature		For signature
Projet à rédiger		Prepare draft
Pour observations		For comments
Pourrions-nous en parler?		May we discuss?
Votre attention	X	Your attention
Comme convenu		As discussed
Suite à votre demande		As requested
Noter et classer		Note and file
Noter et retourner		Note and return
Pour information		For information

Please see attached request for correction.

Regards,

Date

24.02.05

De/From

Céline Faust

EPO - DG 1

01.03.2005

(52)

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## IN THE PCT

## BEFORE THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## IN RE APPLICATION

International Application No.

PCT/CA2003/001278

International Filing Date:

21 August 2003 (21.08.2003)

Priority Date:

29 August 2002 (29.08.2002)

Int'l Patent Classification No.

H01L31/0224

Applicant:

DAY4 ENERGY INC. et al

Title:

ELECTRODE FOR PHOTOVOLTAIC CELLS,  
PHOTOVOLTAIC CELL AND PHOTOVOLTAIC  
MODULE

Agent's Reference:

49709-1

REC'D 15 FEB 2005

WIPO

PCT

February 10, 2005

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20  
Switzerland

BY COURIER

**Attention: A. Werner, Authorized Officer**

Dear Sirs:

**REQUEST TO CORRECT INTERNATIONAL PRELIMINARY EXAMINATION  
REPORT**

We enclose herewith a copy of the second page of the International Preliminary Examination Report in respect of the subject application and refer you to Item I, subparagraph 1, under the heading "Description Pages", which indicates that description pages 1, 2 and 2a were received on 25 June 2004 with letter of 22 June 2002. The 22 June 2002 date is prior to the international filing date and the document submitted nearest to 25 June 2004 is the Request for Recordal of Applicant's Change of Address.

In fact, new description pages 1, 2 and 2a were provided in an Amendment Under Article 34 filed 12 March 2004. The Written Opinion correctly referred to this date when it recognized the new pages had been submitted.

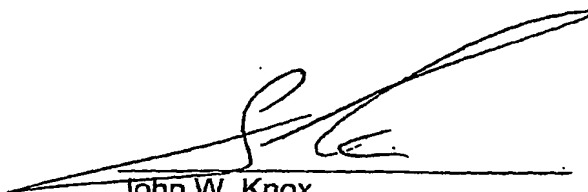
Page 1 of 2

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01-03-2005

Please check your records and issue a new International Preliminary Examination Report referring to pages 1, 2 and 2a as being filed 12 March 2004, as appropriate.

Thank you for your attention to this matter.



John W. Knox  
FETHERSTONHAUGH & CO.  
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JWK:cmm  
Encl.: Page 2 of IPER

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**International application No. **PCT/CA 03/01278****I. Basis of the report**

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

3-14 as originally filed  
1, 2, 2a received on 25.06.2004 with letter of 22.06.2002

**Claims, Numbers**

1-19 as originally filed

**Drawings, Sheets**

1/19-19/19 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

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